REMARKS

This amendment and these remarks are responsive to the final Office action dated November 6, 2003. Claims 18, 25-36, and 45-52 are pending in the application. Claims 18 and 25-36 are withdrawn from consideration. Claims 45-52 are rejected. Claims 18, 25-36, and 45-52 are subject to a restriction requirement. Claims 45-52 are canceled. New claims 53-56 are added. In view of the amendments above and the following remarks, the applicants respectfully request continued examination of the application.

The Claimed Invention

Applicants believe that a review of the salient aspects of the claimed invention would be helpful, before specifically discussing the invention in view of the cited prior art.

The separation of heavy isotopes in mixtures containing isotope mixtures is typically very difficult. As the properties of such isotopes may be very similar, physical separation, such as by distillation, is particularly difficult. For example, in comparison with a relatively light component (such as ^{16}O in the case of mixtures of oxygen isotopes), it is difficult to increase the concentration ratio of heavy isotopes (^{17}O and ^{18}O for the case of oxygen) as the ratio of their vapor pressures is typically close to 1.

During distillation, since the vapor pressure of heavy isotopes is low in comparison with that of light components, the heavy isotopes are concentrated in the liquid phase. However, because the kinetic energy is large for components having a relatively high vapor pressure, it is also easy to mix the high-vapor-pressure components which may be present in the vapor phase back into the liquid phase. It

therefore becomes difficult to increase the concentration ratio of heavy isotopes, because such light isotope components readily intermix with the enriched heavy isotope.

The apparatus of claim 53 includes a plurality of distillation columns constructed in a cascade, where each of the columns includes a reboiler and a condenser, and is configured to facilitate heavy isotope enrichment. In particular, the claimed apparatus includes the following features:

(A) The outlet of the reboiler of the first distillation column is directly connected to the inlet of the condenser of the second distillation column via an introduction conduit that introduces a portion of vapor drawn from the reboiler directly to the condenser of the second distillation column.

(B) The outlet of the reboiler of the first distillation column is also connected to the first distillation column by means of a conduit (shown by reference symbol 24 in Fig. 1) that returns another portion of the vapor drawn from the reboiler back to the first distillation column.

(C) The outlet of the condenser of the second distillation column is directly connected to the inlet of the reboiler of the first distillation column via a return conduit that returns a portion of the liquid drawn from the condenser back to the reboiler of the first distillation column.

(D) The outlet of the condenser of the second distillation column is connected to the second distillation column by means of a conduit (shown by reference symbol 25 in Fig. 1) which returns another portion of the liquid drawn from the condenser back to the second distillation column.

Feature (A) permits the vapor obtained in the reboiler of the first distillation column to be injected as it is into the condenser of the second distillation column. Moreover, Feature (C) permits the liquid obtained in the condenser of the second distillation column to be injected as it is into the reboiler of the first distillation column.

A circulation conduit is thereby formed from the reboiler through the introduction conduit, the condenser, and return conduit back to the reboiler. A large amount of light components are still contained in the distillation product (liquid) from the first distillation column. When a portion of this distillation product (liquid) enters into the circulation conduit in a liquid state, this liquid circulates without going through the process of changing between vapor and liquid, and therefore it is difficult to reduce the concentration of light components.

Since the apparatus of the invention of the present application provides Feature (A), it is possible to change the distillation product from the first distillation column (liquid) completely into a vapor in the reboiler, and to direct it into the condenser of the second distillation column through the introduction conduit.

In the circulation conduit, the distillation product may be repeatedly cycled between the vapor and liquid phase many times while circulating. In this manner, the heavy components are gradually condensed into the liquid phase, and the concentration ratio of the heavy components can be increased to a greater degree than is possible in the first distillation column alone.

Feature (D) permits a portion of the liquid obtained in the condenser of the second distillation column to be returned to the second distillation column by means of

a return conduit (shown by reference symbol 25 in Fig. 1).

Therefore, a portion of the distillation product may be repeatedly cycled between the vapor and a liquid phase many times in a second circulation conduit which is formed between the second distillation column and the condenser, thereby further reducing the concentration of the light liquid-phase components, and further increasing the concentration ratio of the heavy components.

By utilizing the apparatus of claim 53, it is possible to increase the concentration ratio of the heavy components in a multi-isotope composition faster and more efficiently than by previous distillation methods.

Rejections under 35 U.S.C. § 102

Claims 45 and 46 are rejected under 35 U.S.C. § 102(b) as being anticipated by Tervoort et al. (U.S. Patent no. 3,625,835). Applicants have canceled claims 45 and 46, and therefore respectfully suggest the previous rejection is rendered moot. However, applicants suggest that the invention of claims 53-56 is not anticipated by Tervoort et al., for at least the following reasons.

Tervoort et al. discloses a continuous process for preparing cyclohexanone oxime that includes distillation columns A and B with heaters C and D, respectively. Heater C is connected to the bottom portion of column A by means of line 6, and column A is connected to the top portion of column B by means of line 11, with the top portion of the second column B being connected to a condenser F. In other words, heater C is connected to condenser F via the first column A and the second column B. In contrast,

in the apparatus of claim 53, the reboiler of the first distillation column is directly connected to the condenser of the second distillation column via an introduction conduit (Feature (A) as described above).

In the apparatus of Tervoort, the vapor-liquid mixture containing a liquid collected at the bottom portion of the first column A is supplied to the second column B by means of line 11. In contrast, in the apparatus of claim 53, since the introduction conduit introduces vapor drawn from the reboiler of the first distillation column directly into the condenser of the second distillation column, the distillation product from the first distillation column (liquid) is changed into a vapor in the reboiler, and is supplied to the condenser of the second distillation column in a vapor state (Feature (A) as described above).

In the apparatus of Tervoort, condenser F is connected to heater C via the bottom portion of distillation column A. In contrast, in the apparatus of claim 53, the condenser of the second distillation column is directly connected to the reboiler of the first distillation column via the return conduit (Feature (C) as described above).

In the apparatus of Tervoort, there is no line which returns liquid obtained in condenser F of the second column B back to the second column B. In contrast, in the claimed apparatus, the condenser of the second distillation column is connected to the second distillation column by a conduit (shown by reference symbol 25 in Fig. 1) that returns liquid obtained in the condenser back to the second distillation column.

In order to anticipate a claim under 35 U.S.C. § 102, the cited reference must disclose each and every element of the claim. As the Tervoort reference fails to disclose

each and every element of claim 53, applicants suggest that the claimed apparatus is not anticipated by the Tervoort reference. As claims 54-56 depend from claim 53 and incorporate the limitations of the base claim, they are similarly not anticipated by the reference. In view of the above remarks, applicants suggest claims 53-56 are not anticipated by Tervoort et al.

Rejections under 35 U.S.C. § 103

- Claims 47 and 50 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Tervoort et al. (U.S. Patent no. 3,625,835) in view of Glitsche et al. (U.S. 3,969,447) or Chen et al. (U.S. Patent no. 4,604,247).
- Claims 45 and 46 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Carney (U.S. Patent no. 1,957,818).
- Claims 47 and 50 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Carney (U.S. Patent no. 1,957,818) as applied to claims 45 and 46, and further in view of Glitsche et al. (U.S. 3,969,447) or Chen et al. (U.S. Patent no. 4,604,247).
- Claims 45, 46, 48, 49, 51, and 52 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Spevack (U.S. Patent no. 4,788,051) in view of Tervoort et al. (U.S. Patent no. 3,625,835) or Carney (U.S. Patent no. 1,957,818).
- Claims 47 and 50 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Spevack (U.S. Patent no. 4,788,051) in view of

Tervoort et al. (U.S. Patent no. 3,625,835) or Carney (U.S. Patent no. 1,957,818) as applied to claims 45 and 46, and further in view of Glitsche et al. (U.S. 3,969,447) or Chen et al. (U.S. Patent no. 4,604,247).

Applicants have canceled claims 45-52, and therefore respectfully suggest the previous rejections are rendered moot. However, applicants suggest that the invention of claims 53-56 is not rendered obvious by Tervoort et al., Glitsche et al., Chen et al., Spevack, or Carney, considered singly or in combination, for at least the following reasons.

Tervoort et al.

As discussed above, the apparatus of Tervoort is distinct from the apparatus of claim 53, in that the apparatus of Tervoort does not include Features (A) to (D) as listed above, and therefore does not include a circulation conduit wherein the distillation product may be repeatedly cycled between the vapor and liquid phase many times while circulating, gradually increasing the concentration ratio of the heavy components of the liquid phase.

In addition, the Tervoort reference provides no motivation to modify the disclosed distillation apparatus in order to achieve more efficient separation of isotope mixtures. The apparatus of Tervoort is a distillation apparatus for the purpose of separating cyclohexanone oxime from a solvent. Benzene, toluene, xylene, methyl cyclopentane, and cyclohexane are provided as examples of the solvent.

The boiling points of each of these compounds are as follows:

Cyclohexanone oxime	206-210 °C
Benzene	80.1 °C
Toluene	110.6 °C
Xylene	135-145 °C
Methyl cyclopentane	72 °C
Cyclohexane	81 °C

The boiling point of cyclohexanone oxime, which is the object of separation in the apparatus of Tervoort, is substantially higher than those of the solvents used in the disclosed reaction. In contrast, the purpose of the instant apparatus is to separate isotopes having very similar physical properties, where the difference in boiling points is small. There can be no suggestion or motivation in Tervoort to modify the distillation apparatus in the manner required so as to obtain the claimed distillation apparatus, because to do so would change the operating principle of the Tervoort apparatus, that of separating cyclohexanone oxime from substantially lower boiling solvents.

Carney et al.

The apparatus of Carney differs from the apparatus of claim 53 in at least the following particulars:

a) In the apparatus of Carney, the pipe (return line) 22 is not connected to the condenser 25 of the column 2 downstream, and is also not connected to the heating element (reboiler) 7 of the column 1 upstream. Pipe 22 simply connects columns 1 and 2. In contrast, in the apparatus of claim 53 includes a direct connection between the

condenser of the second distillation column and the reboiler of the first distillation column via the return conduit (Feature (C)).

The action indicates that, based on the disclosure of Carney at lines 101-109 of page 3, setting the connecting location of the return conduit to be the position recited in claim 53 would be easy. However, the Carney reference is premised on directly returning the back-feed to the column upstream, and no consideration is given whatsoever in the cited reference to returning the distillation product to the reboiler. One of ordinary skill in the art, given the guidance of Carney, would not be motivated to directly connect the reboiler and the condenser by means of a return conduit.

In the Carney apparatus, the branch (introduction conduit) 16 connects the condenser 11 of the first column 1 to the second column 2, and the liquid obtained in the condenser 11 is introduced into the second column 2 through the branch 16. In contrast, in the instant apparatus, the reboiler of the first distillation conduit is directly connected to the condenser of the second distillation column via the introduction conduit (Feature (A)).

The action indicates setting the connecting location of the introduction conduit to be the location recited in claim 53 would be easy, based upon the Carney disclosure at lines 101-109 of page 3 of Carney. However, the Carney reference describes the location on the column upstream to which the back-feed is to be returned, and is premised on directly returning the back-feed to the column upstream. No consideration is given whatsoever to supplying the distillation product to the condenser. Accordingly, one of ordinary skill in the art would not be lead by the Carney disclosure to directly

connect the reboiler and the condenser by means of the introduction conduit, as featured in the claimed apparatus.

In the apparatus of Carney, the liquid obtained in condenser 11 of the first column 1 is supplied to the second column 2 by branch 16. In contrast, in the claimed apparatus the introduction conduit is constituted so as to introduce the vapor obtained in the reboiler of the first distillation column directly into the condenser of the second distillation column, so that the distillation product from the first distillation column (liquid) is changed into a vapor in the reboiler, and is supplied into the condenser of the second distillation column in a vapor state. There is no motivation or suggestion in Carney to modify the disclosed apparatus so as to arrive at the claimed invention.

The apparatus of Carney is a distillation apparatus for the purpose of separating a plurality of organic compounds having different compositions. The boiling points of such organic compounds typically differ from each other substantially. In contrast, the purpose of the instant apparatus is to separate isotopes having very similar physical properties, where the difference in boiling points is small. There is therefore no suggestion or motivation in Carney to modify the distillation apparatus in the manner to obtain the claimed distillation apparatus, because to do so would change the operating principle of the Carney reference.

Unless there is a particular suggestion or motivation located in the prior art itself to modify the teaching of the reference, *prima facie* obviousness may not be established. This motivation cannot be found in the applicants' specification, but must be found in the prior art. Merely arguing that such modifications would be within the abilities of

one of ordinary skill similarly does not establish *prima facie* obviousness, in the absence of such suggestion or motivation.

Similarly, if the proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, or if the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, there can be no motivation or suggestion to modify or combine the references.

Spevack

Spevack discloses an isotope enrichment apparatus. However, the Spevack apparatus does not include the connection of a reboiler and a condenser using an introduction conduit and a return conduit, in the manner recited in instant claim 53, therefore the Spevack apparatus fails to exhibit the advantageous operation of the claimed apparatus in increasing the concentration ratio of the heavy components in a multi-isotope mixture quickly and efficiently.

In order to establish *prima facie* obviousness, the cited prior art must disclose each and every element of the claim. As none of the Tervoort, Carney, and Spevack references disclose the elements of the apparatus of claim 53, even in combination, the Tervoort, Carney, and Spevack references fail to establish the *prima facie* obviousness of claims 53-56.

Similarly, even in combination with the Glitsch et al. or Chen et al. references, the Tervoort, Carney, and Spevack references fail to disclose the elements of the

apparatus of claim 53, and therefore fail to establish the *prima facie* obviousness of claims 53-56.

The applicants suggest that there is no suggestion or motivation in the cited references to modify the teaching of the references to arrive at the claimed separation apparatus. Further, the cited references fail to provide a reasonable expectation of the success of the claimed apparatus. Additionally, that the cited references singly or in combination fail to teach or suggest each and every element of claims 53-56. For these reasons, the applicants suggest that the cited references fail to establish the *prima facie* obviousness of the claimed apparatus.

In view of the remarks above, the applicants believe that the application is in condition for allowance. Accordingly, applicants respectfully request that the Examiner issue a Notice of Allowability for the pending claims. If the Examiner has any questions, or if a telephone interview would in any way advance prosecution of the application, please contact the undersigned agent of record.

CERTIFICATE OF MAILING

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail, postage prepaid, to: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450 on May 6, 2004.

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Respectfully submitted,

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